

MECHANISATION SYMPOSIUM

HISTORICAL REVIEW OF SUGARCANE
MECHANISATION IN AUSTRALIA

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Historical

Almost any historical review tends to uncover some surprising information during the course of the research. In Australia the sugar industry is relatively young and, so far as Queensland is concerned, it goes back no further than 1864; and, from its inception indentured labour from the South Pacific islands was used on the plantations until the turn of the century.

During this early period there was no recorded shortage of labour, either for cultivating or harvesting the crop. And herein lies the surprise, for during those early years in the Queensland industry there is on record much reference to attempts to fabricate cane harvesting machines. As early as 1889 a model of a harvester was displayed before a Royal Commission on the Sugar Industry and, in 1892, one complete machine of another type was demonstrated.

In the following year a machine was patented, and the specification given included a cutting device which sounds very similar to the modern chain saw, wire ropes fitted with teeth or prongs to elevate the stalks to a platform, revolving knives to sever the tops, and side delivery on to a wagon. Many other reports of harvester inventions are on file up to the year 1900.

But the first machine to reach the stage where commercialisation appeared probable was the Falkiner which in 1924 was demonstrated as a functioning harvester. Demonstrations ceased in 1927 when the machine was taken to Florida for further development. It was at this stage — about 1930 — that the Falkiner harvester was converted from a full-stalk to a chopper type machine.

In the middle thirties Fairymead Sugar Company of Queensland, in conjunction with A. C. Howard, developed the Howard harvester which was also a chopper type and this was seen in operation during the period of the 1935 I.S.S.C.T. Congress. In more recent years, when modern chopper-type harvesters were being developed, and some enquiries were made as to why the Howard machine was not persisted with, the interesting answer was given that "juice losses were too serious". In the light of recent discoveries regarding the activity of leuconostoc in chopped-up cane, it may be claimed that cane deterioration was first recorded in Queensland in the middle thirties; but, at that time, the reasons were not known.

The start of modern developments

There was a hiatus in harvesting mechanisation until the late 1940's, with the exception of one large plantation which successfully developed and used its

own full-stalk harvesters. Up to this time there was no real shortage of cane-cutting labour except during the war years. But then a combination of circumstances aroused a degree of activity and interest which did not wane, despite the frustrations experienced by the inventors. The factors which led to this situation included an increasing difficulty in attracting labour to this arduous occupation, a growing belief that there were cost savings to be made and a realization that the growth of the industry would not be paralleled by a larger labour force.

An industry Mechanical Harvesting Committee was set up, the main function of which was to give financial assistance to farmer inventors who had promising ideas but lacked money to develop them. From the inception of the Committee's work the strongly expressed aim was the development of harvesters which would cut efficiently and cleanly, and which would neither have an adverse effect on farming operations nor reduce the quality of cane supplied to the mills.

The Committee's help was an important factor in some of the developments of both full stalk harvesters and loading machines, both front-end and boom type. The first commercial development which attained popularity in a short time was the front-end loader; and its rapid acceptance and adoption was hastened by the then growing shortage of cane-cutting labour. The front-end loader had the dual advantage of eliminating the most arduous portion of the cane-cutters' task and, at the same time allowing him, within his allotted working hours, to cut more cane.

Detailed examination of performance figures, made in 1968, illustrates the improved output per unit of labour when the loading operation is taken over by machinery. It was found that the tons cane cut per man varied as follows:

	<i>Tons per man day</i>
1. Manually cut, topped and loaded . . .	9.00
2. Manually cut and topped by employee; employee also assists mechanical loader	14.35
3. Manually cut by employee; mechanically topped and loaded by employer . . .	20.83

The difference between the 9.00 tons cane per day for the full operation, and the 14.35 tons cane per day for cutting and topping (plus some assistance with the loading) represents an increase of 59.4 per cent. in cane-cutting and topping output.

The Full Stalk Harvester

The next planned step in the overall mechanisation of the harvest, following the success of the loading operation, was the development, to a successful commercial stage, of full-stalk harvesting. A number of different machines became available, and were successful in erect, burnt crops. Their deficiencies were principally related to inability to handle lodged or badly sprawled cane. Improved pick-up and separation devices were gradually developed and incorporated. And a parallel expansion in the use of boom-and-grab loaders (as distinct from the front-end type) was responsible for determining optimum methods for spacing and placement of cane bundles by the harvesting machines so that loader movement would be reduced to a minimum. Up to this stage the design and development of loading and harvesting machinery followed the progressive steps of initiation in a farm workshop, testing on the farm, co-operation with local engineering establishments to the stage of commercialization and, with successful machines, manufacture and distribution. Mechanisation of the harvest obtained its initial impetus from within the industry and it was not until the trend was strongly apparent that the major farm implement manufacturers became interested in contributing to the development.

The Chopper Harvester

The next step was a revolutionary one. One major manufacturer of farm machinery adopted the engineering principle that the placement of harvested cane on the ground, and the subsequent picking-up for loading, was wasteful in time and energy as well as contributing to the content of soil and other extraneous matter in the loaded product. This manufacturer accordingly designed a harvester which would load simultaneously and, to reduce the problem of handling stalks of varying length and curvature, the design incorporated the cutting of the stalks into short lengths. Although this concept necessitated a change from the conventional transport vehicle, on which cane stalks were stacked transversely, to a container which would hold the short pieces of cane, it was argued that the advantages of the new system would outweigh the cost of the change.

It was in 1959 that these machines, which came to be known as "chopper" harvesters, were first used commercially. Although at that time, relatively simple in design compared with their present-day counterpart, they attracted immediate attention and, in subsequent years, attained a popularity which was limited only by the mills' ability to supply bins (as the containers are called) to the extent of the demand.

The growth of chopper harvesting in Queensland is not a uniformly distributed one. Some mill areas harvest most of their cane by this system while others have maintained major interest in full-stalk machines. In some cases the reluctance to adopt the chopped-cane method has been related to the fear of deterioration problems which include both destruction of sugar and increased processing difficulties.

Following the introduction and acceptance of the chopper harvester many improvements were made to step up operating efficiency, to reduce breakages and to minimise time-loss under difficult harvesting conditions. Conveyors were altered to provide for side or rear delivery into bins; grids and open slat conveyors were installed to get rid of stones and soil; blowers were incorporated to minimise the content of green and dry leaf material. The high capacity machines of today bear only a superficial resemblance to those of ten years ago.

The chopper principle was adopted by other manufacturers and, as shown in the accompanying diagrams, some 51 per cent. of the 17.4 million ton cane crop in 1968 was harvested by this type of machine compared with 21 per cent. by full-stalk harvesters.

The advantages of the chopper machine may be summarised as follows:

1. Only one machine is required; separate loaders are not necessary.
2. The later models can eliminate most dirt and trash and produce a cane supply in bins which is generally cleaner than full-stalk cane mechanically cut and loaded on conventional vehicles.
3. No chaining down is required, and there is no loss of cane in transit to the factory.
4. Carrier feeding at the factory is simplified and there is a large reduction in power requirement of bottom and top knives in mill carriers.
5. Fresher cane supply resulting from immediate loading.

Disadvantages claimed for the chopper system may be listed as:

1. An alteration in transport units from cane trucks to cane bins.
2. The necessity to have the cane crushed promptly because of the more rapid deterioration of cut-up cane compared with full-stalk material.

Deterioration of chopped cane

The last mentioned item deserves some elaboration. Although commercial chopper harvesting began in 1959 the deterioration problem was not a live issue until 1962. In the intermediate years the proportion of such cane was sufficiently small to ensure that it was crushed without undue delay after harvesting. But, since the Queensland factories operate basically on a five-day week, with a two-day shut-down, it has been traditional to store sufficient cane on trucks in the mill yard to ensure a supply for the start-up at the beginning of each week. So, as the proportion of chopped cane increased between 1959 and 1962 some of it became included in the weekend stored supply.

Attention was first drawn to this material by the sour smell associated with the bins, and the first tests indicated a loss of sucrose and a higher juice acidity. Several years of follow-up work defined the problem as follows:

1. The cane deterioration was much faster than in full-stalk cane.
2. It was found to be due to leuconostoc infection.

3. The leuconostoc organisms were not present inside green or burnt standing cane, but the cut ends of the chopped cane were infected at the instant of cutting.
4. The pathogens caused significant drops in the sugar content, juice purity and pH after storage for 24 hours or more, and a rise in dextran in the juice.
5. Bactericides and antibiotics, applied at the instant of cutting, did not prevent the ingress of infection or slow down the rate of spread.
6. The degree of infection was increased if the cut ends were bruised or shattered by blunt or maladjusted cutting knives.

The only practical minimisation of the deterioration problem resulted from management. In one case the burning of cane before harvest became a daily operation, and only one day's supply of cane could be burnt; in the other, the cane transport systems were altered to reduce the time between harvesting and crushing. In addition, in some areas, overtime and roster arrangements were altered in an attempt to eliminate weekend storage of chopped cane. These measures have been successful.

Effect of mechanisation on labour requirement

In Table I the effect on manual-cutter engagement is very marked. From a peak of 9,046 cutters in 1958 the number had shrunk to 2,748 in 1968. But simultaneously the seasonal workers engaged on harvesters and loaders grew from 58 to 4,059. Thus, the gross force, seasonally employed for harvesting

and loading, was reduced from 9,104 to 6,807, in a period when the total crop increased from 9.7 to 17.4 million tons of cane.*

General

Mechanisation of the harvest, both in cutting and loading has advanced at a high rate in Queensland. Prior to machines being developed, it was recognized that the industry would not sacrifice standards of field efficiency or cane cleanliness. The types of machines which have been accepted have not reduced those standards, and this has contributed largely to the rapid growth of mechanisation.

Mechanical cutting of the crop is not always as efficient as is hand cutting because ground inequalities, or badly lodged cane, can result in high cutting, thus leaving some above-ground stubble. Stubble shaving has therefore become a more commonly used practice than before.

Badly lodged crops cannot be effectively topped by mechanical harvesters, and ground crews are required in some cases to top the stalks manually; this labour is included in the table showing the employed work force. Short suckers, normally rejected in manual harvesting, cannot be segregated by a machine. These, also, are eliminated by the ground crew where they occur frequently in a lodged crop. But chopper harvesters equipped with blowers will eliminate most top leaves and sucker tops, even if a ground crew does not remove them.

Millowners have the authority to apply penalties on cane deliveries which contain more than a specified percentage of extraneous material, and the penalty application is generally made at about the 97 per cent. clean cane figure. If the cane delivery is determined by physical analysis at over 97 per cent. whole cane, penalties are not applied. Millowners have not reduced their standards of required cane cleanliness since the introduction of mechanical harvesting, and the general statement can be made that mechanically cut crops do not, on the average, carry significantly greater amounts of extraneous material than the previously manually harvested crops; this statement can be more accurately applied to harvesting machines which incorporate grids, slatted conveyors and blowers for removal of stones, soil and leaves.

The development of mechanical harvesting in Queensland has been an effective and satisfactory operation. In a period of ten years it has progressed to the stage where, in 1968, 71.6 per cent of the crop was cut mechanically and 98.6 per cent. was loaded by machines. Of the 12.5 million tons cut by mechanical harvesters 8.8 million tons were handled by chopper-type harvesters and 3.6 million tons by full-stalk machines.

TABLE I

Year	Manual Cutters	Seasonal Workers on Harvesters or Loaders	Total Employed Harvesting Force	Total Crop (tons)
1954	8,171	—	8,171	9,864,305
1955	8,739	—	8,739	8,616,163
1956	8,720	—	8,720	8,978,081
1957	8,505	34	8,539	8,945,617
1958	9,046	58	9,104	9,740,795
1959	8,178	63	8,241	8,427,731
1960	7,540	126	7,666	8,685,426
1961	7,396	246	7,642	9,020,734
1962	7,746	374	8,120	12,098,582
1963	7,516	620	8,136	11,500,672
1964	6,961	1,150	8,111	14,321,303
1965	5,917	1,954	7,781	13,549,748
1966	4,902	2,867	7,769	15,514,452
1967	3,874	2,825	6,699	15,718,297
1968	2,748	4,059	6,807	17,414,536

Note: Farmers who cut some or all of their own cane, manually or mechanically, are not included in these figures. Such self-employed labour varied from 1,993 in 1954 to 1,700 in 1968.

*The employed labour figures do not include farmers who cut and/or loaded their own cane. These amounted to 1,604 in 1958 and 1,700 in 1968.

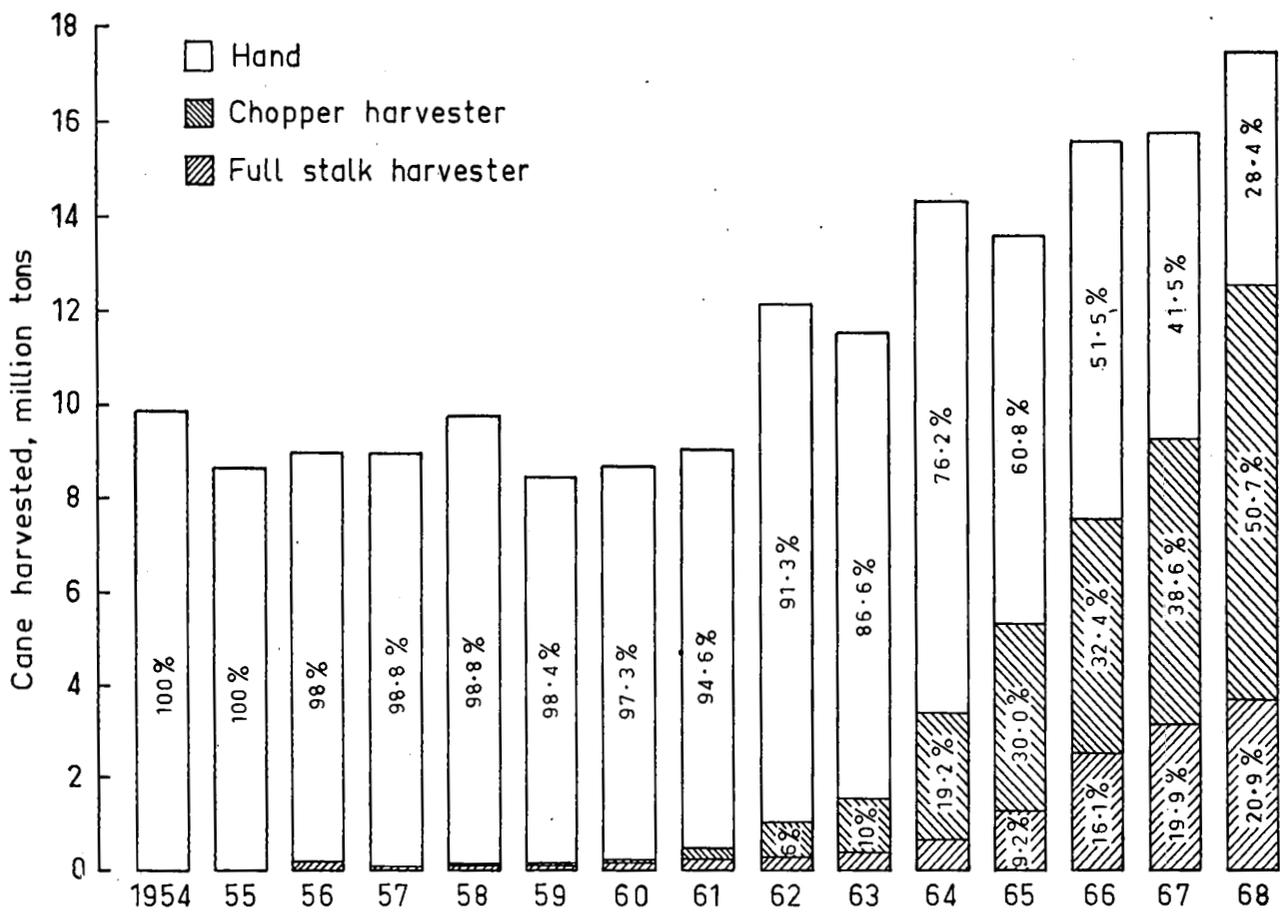


FIGURE 1: The tonnage, and the percentage of the total crop, cut (a) manually, (b) by chopper machines and (c) by full-stalk harvesters from 1954 to 1968.

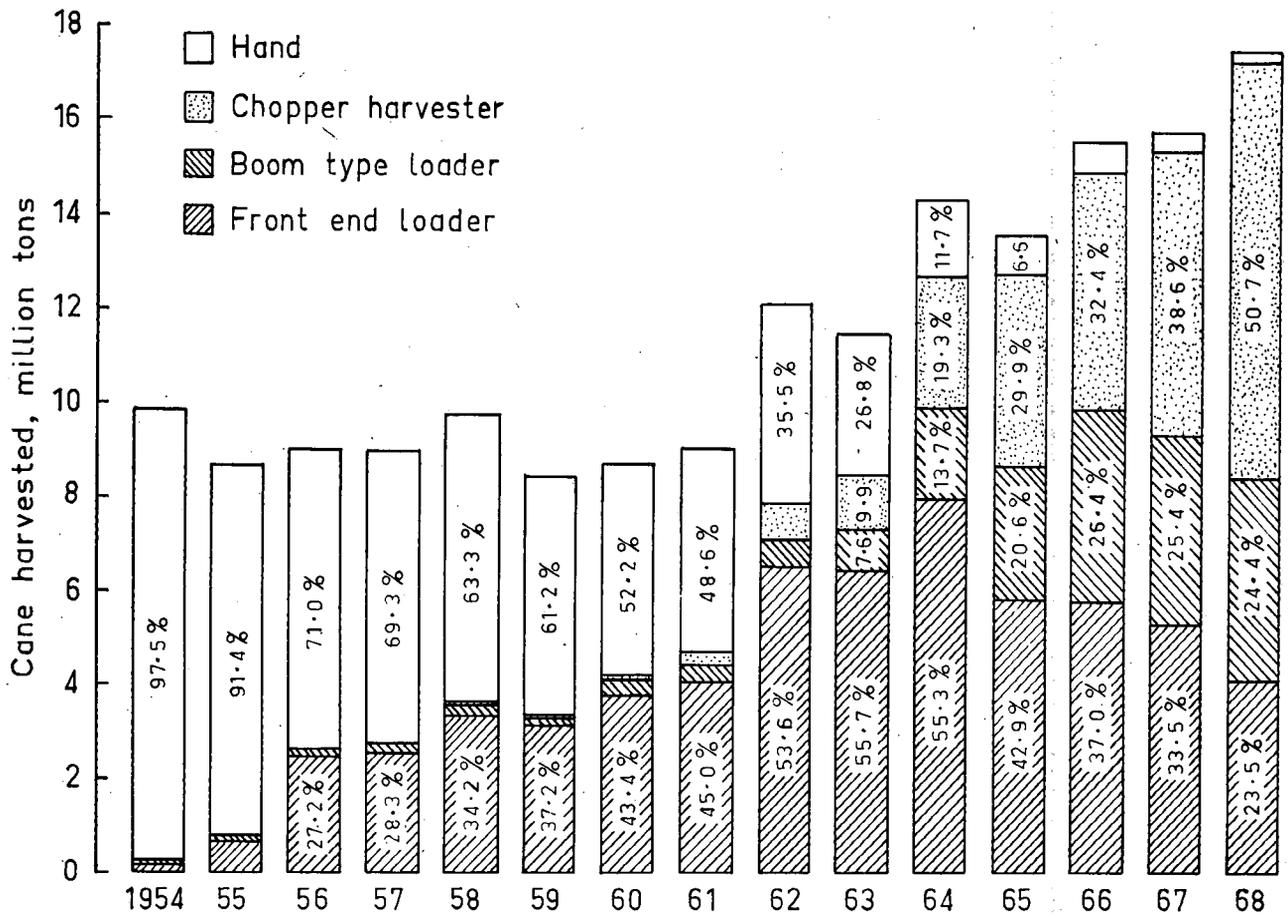


FIGURE 2: The tonnage, and the percentage of the total crop, loaded (a) manually, (b) by chopper harvesters, (c) by boom-type loaders and (d) by front-end loaders from 1954 to 1968.

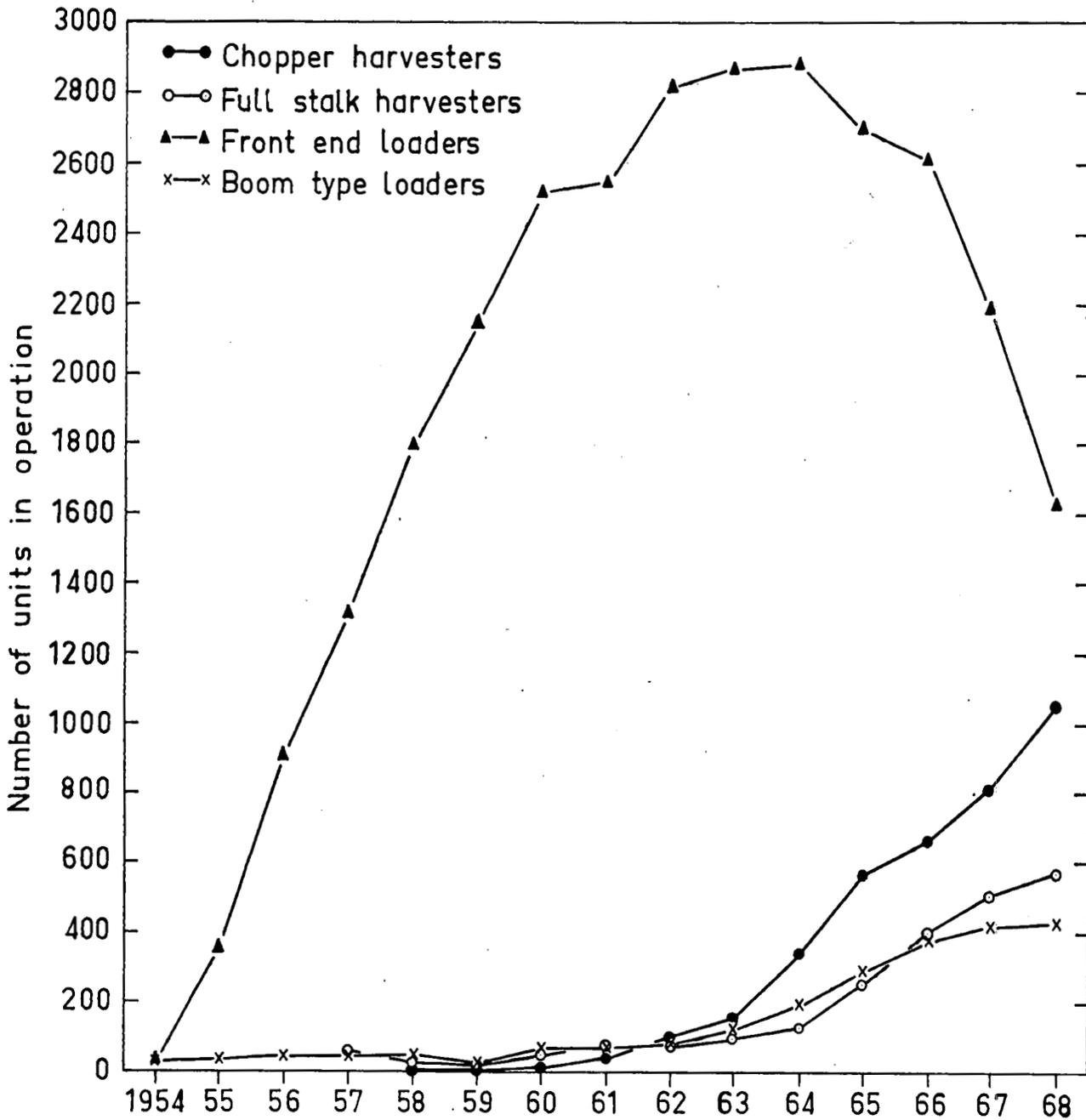


FIGURE 3: The numbers of mechanical units used in the harvest from 1954 to 1968.